

## PATENT ABSTRACTS OF JAPAN

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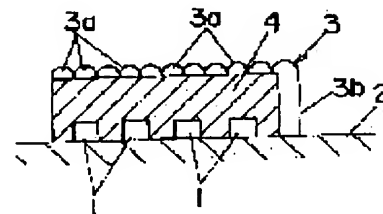
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## (54) LED LIGHTING DEVICE

## (57)Abstract:

PROBLEM TO BE SOLVED: To provide an LED lighting device which enables high-density packaging of an LED chip on a board, while restraining the rise in temperature.

SOLUTION: A plurality of LED chips 1 are mounted on a board 2, and these LED chips 1 are sealed hermetically in a container 3 made of an optically transparent material, thus constituting an LED module. In the container 3, a liquid 4 made of water or an organic solvent such as alcohol or the like is filled. Since the LED chips 1 makes direct contact with the liquid 4 and radiate heat in the container 3, the rise in temperature due to the heating of the LED chips 1 can be restrained. As a result, the packaging density of the LED chips 1 onto the board 2 can be increased, and the luminous efficiency of the LED chip 1 itself can be enhanced also.



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**CLAIMS**

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[Claim(s)]

[Claim 1] The LED lighting system characterized by the thing of an LED chip or a substrate which either is cooled directly at least and changed in the LED lighting system which prepares two or more light emitting diode (LED) chips, and changes on a substrate.

[Claim 2] The LED lighting system according to claim 1 characterized by being filled up with a liquid in this container while sealing an LED chip in the container possessing the optical means which changes the luminous intensity distribution of the light emitted from an LED chip.

[Claim 3] The LED lighting system according to claim 2 characterized by having the pipe for cooling which is open for free passage in a container.

[Claim 4] The LED lighting system according to claim 1 characterized by being filled up with a gas in this container while sealing an LED chip in a container.

[Claim 5] The LED lighting system according to claim 1 characterized by embedding a heat pipe at a substrate.

[Claim 6] The LED lighting system according to claim 1 characterized by arranging a Peltier device in the near field where the LED chip of a substrate is not mounted.

[Claim 7] The LED lighting system according to claim 1 characterized by joining an LED chip to the thermoelement prepared on the substrate.

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**DETAILED DESCRIPTION**

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the LED lighting system which prepares two or more light emitting diode (LED) chips, and changes on a substrate.

[0002]

[Description of the Prior Art] Conventionally, although light emitting diode is used individually in many cases, it needs to use the light emitting diode chip (it abbreviates to an "LED chip" hereafter.) of 10 - 100 numbers for constituting the lighting system using light emitting diode.

[0003]

[Problem(s) to be Solved by the Invention] When two or more LED chips constitute a lighting system as mentioned above, it is generation of heat from an LED chip to become a problem most, and the calorific value per unit area of a substrate also increases, so that the packaging density to the substrate of an LED chip becomes high. Thus, trouble will be caused to the curvature of a substrate and the endurance of an electric connection part by heat when there is much generation of heat. Moreover, the more the LED chip itself has good luminous efficiency and low-temperature one becomes an elevated temperature, luminous efficiency will fall and, the more the brightness as a lighting system will also fall.

[0004] Succeeding in this invention in view of the above-mentioned situation, the place made into the purpose is to offer the LED lighting system which suppressed the rise of temperature and made possible high density assembly of an LED chip to a substrate.

[0005]

[Means for Solving the Problem] Invention of claim 1 is characterized by the thing of an LED chip or a substrate which either is cooled directly at least and changed in the LED lighting system which prepares two or more light emitting diode (LED) chips, and changes on a substrate in order to attain the above-mentioned purpose, the rise of temperature is suppressed by raising heat dissipation nature, and the high density assembly of an LED chip to a substrate becomes possible, and can realize the small LED lighting system of high brightness.

[0006] While invention of claim 2 seals an LED chip in the container possessing the optical means which changes the luminous intensity distribution of the light emitted from an LED chip in invention of claim 1, it is characterized by to be filled up with a liquid in this container, heat is radiated in the heat from an LED chip with a liquid, and the rise of temperature is suppressed, and the high density assembly of an LED chip to a substrate becomes possible, and can realize the small LED lighting system of high brightness.

[0007] In invention of claim 2, invention of claim 3 can be characterized by having the pipe for cooling which is open for free passage in a container, and can raise heat dissipation nature further. While sealing an LED chip in a container in invention of claim 1, it is characterized by being filled up with a gas in this container, heat is radiated in the heat from an LED chip with a gas, and the rise of temperature is suppressed, and the high density assembly of an LED chip to a substrate becomes possible, and, as for invention of claim 4, can realize the small LED lighting system of high brightness.

[0008] Invention of claim 5 can be characterized by embedding a heat pipe at a substrate in invention of claim 1, and with a heat pipe, heat is radiated in the heat from an LED chip, and the rise of temperature is suppressed, and the high density assembly of an LED chip to a substrate becomes possible, and can realize the small LED lighting system of high brightness. Invention of claim 6 can be characterized by arranging a Peltier device in the near field where the LED chip of a substrate is not mounted in invention of claim 1, and by the Peltier device, heat is radiated in the heat from an LED chip, and the rise of temperature is suppressed, and the

high density assembly of an LED chip to a substrate becomes possible, and can realize the small LED lighting system of high brightness.

[0009] In invention of claim 1, invention of claim 7 is characterized by joining an LED chip to the thermoelement prepared on the substrate, can control the temperature rise of the LED chip itself by cooling each LED chip by the thermoelement, raises the luminous efficiency of an LED chip, and can realize the lighting system of high brightness.

[0010]

[Embodiment of the Invention] (Operation gestalt 1) The side-face sectional view of the operation gestalt 1 of this invention is shown in drawing 1 . As shown in drawing 1 , two or more LED chips 1 are mounted on a substrate 2, it is sealed in the container 3 in which these LED chips 1 were formed with the ingredients (for example, plastics, glass, etc., such as an acrylic and a polycarbonate) which have translucency, the LED module is constituted, and the LED lighting system applied to this invention, using such an LED module two or more is formed.

[0011] Lens 3a is prepared in the upper part of the LED chip 1 and the container 3 which counters, and micro processing by which the optical design was carried out so that various optical control might be possible on the front face is performed. However, the above-mentioned micro processing is [ that what is necessary is just to prepare suitably if needed ] good also as the flat configuration and the spherical configuration where the above micro processing is not performed for the upper part of a container 3. Moreover, a diffusion plate may be formed instead of lens 3a. In addition, a container 3 and a substrate 2 are fixed using proper means, such as adhesion immobilization by adhesives etc., and mechanical fitting.

[0012] On the other hand, it fills up with the liquid 4 which consists of water or an organic solvent like alcohol in a container 3. Here, enclosure of the liquid 4 into a container 3 is performed by pouring in with a syringe etc. through hole 3b opened in some containers 3, and closing with adhesives etc., or constituting a container 3 from a body and a transparence lid which has lens 3a, and fitting in a body and a transparence lid mechanically in a liquid 4.

[0013] Since it \*\*, and according to this operation gestalt the LED chip 1 contacts a liquid 4 and directly and radiates heat within a container 3, the rise of the temperature by generation of heat of the LED chip 1 can be suppressed. Consequently, while being able to enlarge packaging density of the LED chip 1 to a substrate 2, the luminous efficiency of LED chip 1 the very thing can also be raised.

(Operation gestalt 2) The side-face sectional view of the operation gestalt 2 of this invention is shown in drawing 2 . This operation gestalt has the description in the point equipped with the pipe 5 which is open for free passage in a container 3 in the configuration of the operation gestalt 1, and other configurations give the same sign to the part which is common since it is common in the operation gestalt 1, and omit explanation.

[0014] Spherical section 5a is prepared in a part for the point of a pipe 5. Here, after not being completely filled up with a liquid 4 in a pipe 5 but being left and filled up with space, the air which remained in the interior is exhausted using a vacuum pump. Therefore, the inside of a pipe 5 is decompressed, the boiling point of a liquid 4 falls, and a liquid 4 comes to boil easily with the heat emitted from the LED chip 1. It moves to spherical section 5a at the tip of a pipe 5, it is cooled, and the vaporized liquid 4 returns to a liquid (principle of a heat pipe).

[0015] It \*\* and heat dissipation can be further promoted by having formed the pipe 5 in the container 3 as compared with the operation gestalt 1. And since a liquid 4 is boiled compulsorily and it cools, cooling effectiveness (heat dissipation effectiveness) also has the advantage of being very good. In addition, cooling effectiveness can be further gathered by radiating heat with suitable heat dissipation means (a heat sink, blower, etc.) in the part (spherical section 5a) by which the vaporized liquid 4 is cooled (cooling).

[0016] In addition, although air bubbles will be generated within a container 3 and the light of the LED chip 1 will be scattered about by the above-mentioned air bubbles if a liquid 4 is boiled, the effectiveness of the surface light source can be taken out with scattering the light of the LED chip 1 which is the point light source on the contrary. Moreover, since fluctuation of the light by air bubbles arises, it is also possible by carrying out color mixture of the luminescent color of the LED chip 1 to do so a peculiar production light effect with a motion.

[0017] (Operation gestalt 3) The side-face sectional view of the operation gestalt 3 of this invention is shown in drawing 3 . This operation gestalt has the description in the point filled up with the gas 6 instead of the liquid 4 in the operation gestalt 2, and other configurations give the same sign to the part which is common since it is common in the operation gestalt 2, and omit explanation. The big gas of heat conduction of an argon, helium, etc. of the gas 6 with which container 3 list is filled up in a pipe 5 is desirable. It \*\*, and since it is cooled while

the gas 6 which was able to be warmed by generation of heat of the LED chip 1 moves to the direction of spherical section 5a through a pipe 5, the temperature rise of the LED chip 1 can be suppressed.

[0018] In addition, it is more desirable to form Holes 3b and 5b in container 3 list at a pipe 5, respectively, and to make it open type, as shown in drawing 4 when making the gas 6 for cooling into air. When it is made such open type, although the cooling effect is inferior a little as compared with the configuration which encloses the operation gestalt 1 or the liquid 4 of 2, a design and manufacture of a container 3 of sealing structure can be performed easily, and become advantageous to a productivity list in respect of cost.

[0019] (Operation gestalt 4) The perspective view of the operation gestalt 4 of this invention is shown in drawing 5, and a side-face sectional view is shown in drawing 6, respectively. The LED module M in this operation gestalt forms the heat pipe 12 which passes through the bottom of each hollow 11, and is constituted while it installs many hollows 11 successively on the whole surface of the rectangular substrate 10 and mounts the LED chip 1 in each hollow 11.

[0020] If a substrate 10 is constituted from a MID (Molded Interconnect Device) substrate (the so-called resin shaping substrate) here, the LED module M can be easily manufactured without a special technique by carrying out insert molding of the heat pipe 12 at the time of shaping of a substrate 10. It \*\*, and with this operation gestalt, by letting a heat pipe 12 pass under the LED chip 1 within a substrate 10, since the LED chip 1 is directly cooled using the heat pipe 12 excellent in heat transport capacity, it excels in the cooling effect, and high density assembly of the LED chip 1 and improvement in luminous efficiency can be realized easily.

[0021] In addition, when it constitutes substrate 10' from a printed circuit board by the usual resin shaping, as shown in drawing 7, a slot 13 is established in the hollow 11 of an anti-component side of substrate 10', and the location facing in opposite directions, a heat pipe 12 is embedded in this slot 13, and it may be made to carry out adhesion immobilization.

(Operation gestalt 5) The side-face sectional view of the operation gestalt 5 of this invention is shown in drawing 8.

[0022] This operation gestalt has the description in the point which stuck the Peltier cooling module 14 on the near field where the LED chip 1 of a substrate 2 is not mounted, and constituted the LED module M. In addition, it is desirable to use for a substrate 2 the metal thing which has high heat dissipation nature, the thing which fabricated thickness with the MID substrate thinly as much as possible. The Peltier cooling module 14 attaches radiation-fin 14b in one side of Peltier device 14a formed in tabular [thin], and is constituted.

[0023] It \*\*, and with this operation gestalt, the heat generated from the LED chip 1 mounted on the substrate 2 can make radiation-fin 14b able to move the heat to Peltier device 14a electrically by propagation and Peltier device 14a through a substrate 2, and can cool a substrate 2. Here, if current control of Peltier device 14a is performed, the cooling engine performance in the Peltier cooling module 14 is controllable, it becomes possible to maintain a substrate 2 at the constant temperature of arbitration, and lighting of the stable quantity of light can be realized.

[0024] In addition, radiation-fin 14b can change magnitude suitably according to the structure of a lighting system, and when large-sized radiation-fin 14b can be attached, it can use it by natural air cooling. However, to be the structure where the tooth space of radiation-fin 14b cannot be taken, it is necessary to cool radiation-fin 14b compulsorily by a fan etc.

(Operation gestalt 6) The important section side-face sectional view of the operation gestalt 6 of this invention is shown in drawing 9.

[0025] With this operation gestalt, while mounting the thermoelements (Peltier device) 16a and 16b of n mold and p mold through an electrode 15 on a substrate 2, n layer 1a of the LED chip 1 is joined to thermoelement 16b of p mold. You may make it attach the LED chip 1 and a thermoelement 16 by electroconductive glue, soldering, etc., such as a silver paste, here. On the other hand, a thermoelement 16 is Bi<sub>2</sub>Te<sub>3</sub> with the most sufficient property near a room temperature. A system and Sb<sub>2</sub>Te<sub>3</sub> Forming with the compound semiconductor of a system is desirable.

[0026] It \*\*, and if an electrical potential difference is impressed between the wires 17 and electrodes 15 which were attached in p layer 1b of the LED chip 1, while the LED chip 1 will emit light, the LED chip 1 is cooled according to the interface of the LED chip 1 and thermoelement 16b of p mold because a current flows from the LED chip 1 to a thermoelement 16. Thus, since two or more LED chips 1 are separately cooled by the thermoelement 16, the temperature rise of LED chip 1 the very thing is controlled, the luminous efficiency of an LED chip is raised, and the lighting system of high brightness can be realized.

[0027] By the way, although generation of heat arises in the interface of the thermoelements 16a and 16b of n

mold and p mold, if thickness of thermoelement 16a of n mold is made thin and the generated above-mentioned heat is made into the structure missed to a substrate 2, the temperature rise of the LED chip 1 by the above-mentioned generation of heat can be suppressed. In addition, a thermoelement 16 does not necessarily need to be the pair of n mold and p mold, and it may be made to mount only thermoelement 16b of p mold in the electrode 15 on a substrate 2, as shown in drawing 10 . However, cooling effectiveness falls a little in this case.

[0028]

[Effect of the Invention] In the LED lighting system which prepares two or more light emitting diode (LED) chips, and changes on a substrate, since either is cooled directly at least and it changes, the rise of temperature is suppressed by the thing of an LED chip or a substrate for which heat dissipation nature is raised, the high density assembly of an LED chip to a substrate becomes possible, and invention of claim 1 is effective in the small LED lighting system of high brightness being realizable.

[0029] Since invention of claim 2 was filled up with the liquid in this container while it sealed the LED chip in the container possessing the optical means which changes the luminous intensity distribution of the light emitted from an LED chip, heat is radiated in the heat from an LED chip with a liquid, the rise of temperature is suppressed, the high density assembly of an LED chip to a substrate becomes possible, and it is effective in the small LED lighting system of high brightness being realizable.

[0030] Since invention of claim 3 was equipped with the pipe for cooling which is open for free passage in a container, it is effective in the ability to raise heat dissipation nature further. Since invention of claim 4 was filled up with the gas in this container while it sealed the LED chip in the container, heat is radiated in the heat from an LED chip with a gas, the rise of temperature is suppressed, the high density assembly of an LED chip to a substrate becomes possible, and it is effective in the small LED lighting system of high brightness being realizable.

[0031] Since invention of claim 5 embeds a heat pipe at a substrate, heat is radiated in the heat from an LED chip with a heat pipe, the rise of temperature is suppressed, the high density assembly of an LED chip to a substrate becomes possible, and it is effective in the small LED lighting system of high brightness being realizable. Since invention of claim 6 arranged the Peltier device in the near field where the LED chip of a substrate is not mounted, heat is radiated in the heat from an LED chip by the Peltier device, the rise of temperature is suppressed, the high density assembly of an LED chip to a substrate becomes possible, and it is effective in the small LED lighting system of high brightness being realizable.

[0032] Since invention of claim 7 joined the LED chip to the thermoelement prepared on the substrate, it is effective in being able to control the temperature rise of the LED chip itself by cooling each LED chip, raising the luminous efficiency of an LED chip, and being able to realize the lighting system of high brightness by the thermoelement.

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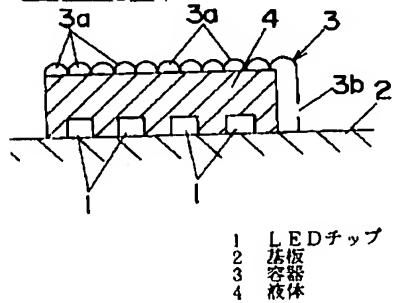
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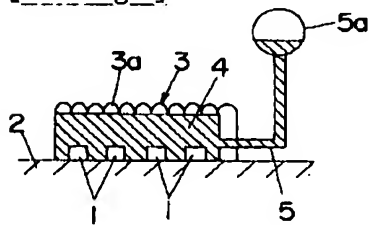
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## DRAWINGS

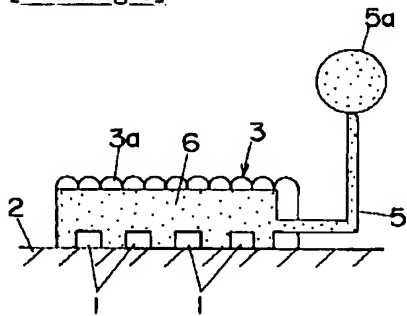
[Drawing 1]



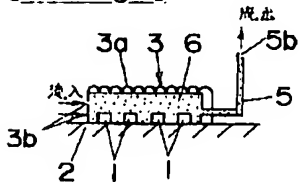
[Drawing 2]



[Drawing 3]



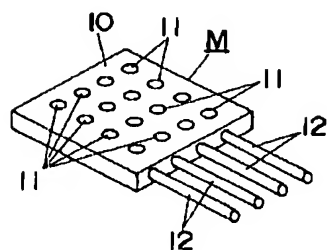
[Drawing 4]



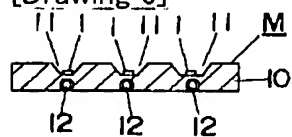
[Drawing 5]



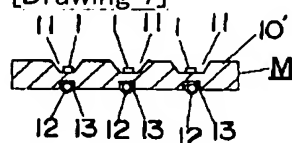




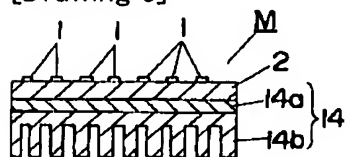
[Drawing 6]



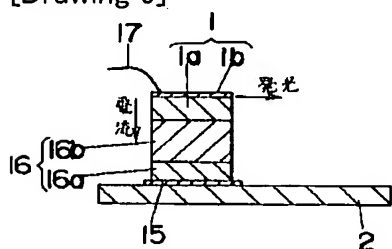
[Drawing 7]



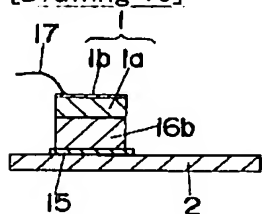
[Drawing 8]



[Drawing 9]



[Drawing 10]



[Translation done.]